CEL –Power Electronics and Electromechanical Systems

T009

Thursday, 23/11/2017

08:30 – 11:30 AM

WORKFORCE DEVELOPMENT AUTHORITY

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ADVANCED LEVEL NATIONAL EXAMINATIONS, 2017, TECHNICAL AND PROFESSIONAL STUDIES

EXAM TITLE:

POWER ELECTRONICS AND ELECTROMECHANICAL SYSTEMS

OPTION: Computer Electronics (CEL)

DURATION: 3 hours

INSTRUCTIONS:

The paper is composed of **three (3) main Sections** as follows:

Section I: Fifteen (15) compulsory questions.	**55 marks**
Section II: Attempt **any three (3)** out of five questions.	**30 marks**
Section III: Attempt **any one (1)** out of three questions.	**15 marks**

Note:

Every candidate is required to carefully comply with the above instructions. Penalty measures will be applied on their strict consideration.

Section I. Fifteen (15) Compulsory questions **55 marks**

01. Explain the linear circuit elements in electrical circuit and give their examples. **3 marks**

02. Define the following terms:

a. Controllers

b. Sensors

c. Filters

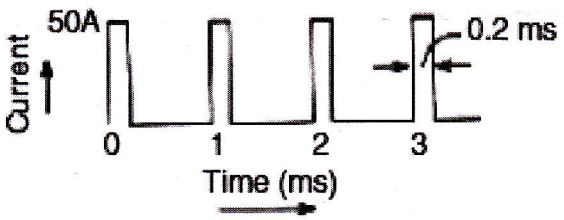
d. Inverter **4 marks**

03. Can an ordinary diode be used as a zener diode? Justify your answer. **3 marks**

04. State the Current-voltage Switching classification. **4 marks**

05. What are power converters that utilize natural commutation? **4 marks**

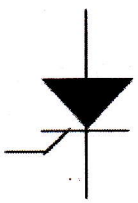
06. The current waveform passing through a diode switch in a switch mode power supply application is shown in Figure below. Find the average, rms, and the peak current. **3 marks**



07. Which features must semiconductor possess in order to operate as an ideal switch? **5 marks**

08. What are characteristics of The Practical Switch? **4 marks**

09. What is the name of the semiconductor symbol shown below and put the names on its terminals **2 marks**



10. List at least four Applications of uni-junction transistor (UJT). **4 marks**

11. Classify choppers depending on the voltage output. **3 marks**

12. Which precautions that must be taken when triggering a Triac?

3 marks

13. Explain the Thyristor commutation techniques. **5 marks**

14. What can happen if diodes are connected in:

a. Series?

b. Parallel?

4 marks

15. Give at least four reasons which may cause the switching devices fail.

4 marks

Section II. Choose and answer any three (3) questions. **30 marks**

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16. A Power MOSFET has $I_{DSS} = 2mA, R_{DS(ON)} = 0.3\Omega$, duty cycle d = 50%, I_D = 6A, V_{DS} = 100V, t_r = 100ns and t_f = 200ns. If the frequency of switching is 40 KHz, then find:

i) on-state loss

ii) off-state loss

iii) turn-on switching loss

iv) turn-off switching loss. **10 marks**

17. i) A power transistor has $V_{cc} = 208V$, $R_c = 20\Omega$;

$V_{CE(SAT)} = 0.9V; V_{BE(SAT)} = 1.1V$ and β=10

Find :

a) $I_c; I_B$

b)The power loss in collector (P_c).

c) Power loss in base(P_B)

ii) Draw construction of SCR using two transistor models.

10 marks

18. What is IGBT? Draw the switching characteristics of IGBT. **10 marks**

19. The BJT is specified to have a range of 8 to 40.the load resistance in R_e=11Ω.The DC supply voltage is V_{cc}=200V and input voltage to the base circuit is V_B=10V.if $V_{CE(SAT)} = 1.0V$ and $V_{BE(SAT)} = 1.5V$.

Find :

a) The value of R_B that results in saturation with a overdrive factor of 5.

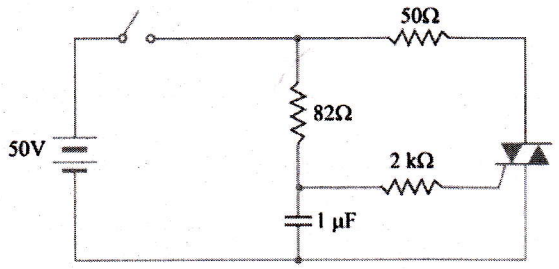
b) The forced β_f.

c) The power loss P_T in the transistor. **10 marks**

20. a) In figure below, the switch is closed. if the triac has fired, what is the current through 50Ω resistor when:

i) Triac is ideal

ii) Triac has a drop of 1V



b) A d.c. to d.c. chopper operates from a 48 V battery source into a resistive load of 24Ω. The frequency of the chopper is set to 250Hz. Determine the average and rms load current and load power values when chopper on-time is 1ms. **10 marks**

Section III. Choose and answer any one (1) question. **15 marks**

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21. Briefly, explain the Modes of Operation in silicon controlled rectifier (SCR).

22. A separately excited DC motor has the following parameters: 220V, 100A and 1450 rpm. Its armature has a resistance of 0.1 Ω. In addition, it is supplied from a 3 phase fully-controlled converter connected to a 3-phase AC source with a frequency of 50 Hz and inductive reactance of 0.5 Ω and 50Hz. At transport factor (α) = 0, the motor operation is at rated torque and speed. Assume the motor brakes re-generatively using the reverse direction at its rated speed. Calculate the maximum current under which commutation is not affected.

23. Explain the formation of a potential barrier in a p-n junction of a semiconductor.